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RAIL STEEL PRODUCTION

By FRED A. KREMSER, '32

By the term rail steel is meant steel which is rolled from railroad rails that have been removed from service. There are several reasons for the removal of these rails from service. Some must be replaced because they have exceeded the allowable wear on the head, particularly at the joints. Another reason for removal is the ever-increasing wheel loads and traffic speeds of railroad transportation of today; these require heavier section of rail than formerly. This requirement results in an overabundance of used rails; that is, more than the roads can use in the development of sidings and similar uses. It was apparent to several manufacturers that it would be an economic waste to remelt the rails in order to reclaim the steel. About 28 years ago a number of manufacturers in the steel industry realized the possibility of utilizing these rails in the manufacture of hard grade steel, the physical properties of the rail being the same as hard grade billet steel. The idea was evolved of heating the rails removed from service and rolling them into reinforcing bars, small shapes, flat bars, angles, tees, etc.

In 1913 the American Society for Testing Materials recognized the industry by setting up a specification covering Rail Steel Reinforcing Bars. From that time the industry grew steadily until today there are a large number of mills devoted entirely to the manufacture of rail steel.

Steel rails for service must pass the most critical inspection from the charge of the raw material to the shipping of the finished product. After inspection during the course of manufacture the rail must be reinspected to see that it comes within required chemical and physical specifications; hence a product of uniform quality is assured.

It is claimed that the rails, after being discarded from the original service, are no longer fit for use. Through constant use while in service the metal undergoes a certain amount of fatigue as it is called; but, through proper heat treatment above the critical range, the rail is again restored to its original condition. This operation is much the same as the annealing of crane chains which are subject to all forms of shock and abuse.

Through the process of rolling the grain of the metal is made finer than in the original rail, as has been proven by photomicrographs. This closer knitting of the grains of metal results in a natural improvement in ductility.

The term "re-rolled" as applied to rail steel is a misnomer. This term could also be applied to billet steel, as the billet is re-heated and then rolled to smaller shapes. The process of rolling rails actually is a continuation of rolling or merely a further reduction in size of material. Re-rolling can be better applied to the process of manufacture of a low grade of steel, low in strength and elastic limit, which utilizes miscellaneous low carbon steel scrap heated to a point of fusion and then re-rolled into the desired shape. This type of steel cannot meet the physical requirements of rail steel.

Rails bought for rolling purposes must pass certain specifications. The rails must weigh more than 50 lb. per yard, must be 5 ft. or more in length, and must be free from frog, switch, curve, bend, twist, or split head section. All rails having passed these specifications are received at the mill and again inspected.

In the primary operations, after the rails are unloaded, it is necessary to reduce them to lengths suitable for rolling, varying usually from 5 to 17 feet. Smaller pieces are not used but are sold for scrap. The reduced lengths are sorted in accordance with nominal weight and length and stored until needed for rolling. These lengths are usually handled by a magnetic crane which has been found convenient in the operations necessary to preparing raw material. The rails taken from stock are weighed and again inspected for defects, and are slowly and uniformly heated. The furnace is of the continuous feed type, the rails being fed into one side in a continuous operation. The conveyor is made of pipes, which are kept cool with water to keep them from melting. The pipe conveyor, being high at the receiving end and low at the ejector end, allows the rails to slide down. The furnace heats the rails to a temperature ranging from 2100 to 2200 degrees. Great care is given to the control of this temperature range. The ejector, at the lower end of the furnace, is a long arm moving in and out of the furnace; when a rail is heated to the proper temperature this arm pushes the rail out the other side of the furnace. The heated rail is carried by a roller conveyor to the slitting mill.

The slitting mill divides the hot rail into three sections, the head, the web, and the flange. The slitter roll's edges, rotating on the surface of the rail, cause it to separate at the desired point. The various sections are then distributed to three separate mills for rough rolling. From the slitting process to the end of the operation, the sections are all handled by laborers and not by machinery. The head of the rail is used for bars of large diameter and other large sections. The web is used for smaller sections such as bars, angles, and flats, and the same use is made of the flange. In special sections, as in the rolling of tee bars and other similar shapes, the web and the flange are used together, the head only being separated in the slitting pass.

In the rolling of large bars the head of the rail is taken to the roughing rolls. The roughing mill consists of one stand with three rolls. After passing through the roughing mill, the head is turned over to the finishing mill.

The bar, now no longer a rail or part thereof, is taken to the finishing mill. The bar is introduced into the first of the finishing rolls, passed through this stand, and then brought over to the last finishing stand, where it is again passed back and forth as in the roughing mill. The finishing mill consists of two stands. One stand has two

rolls, and the other has three rolls. The diameter of the rolls in all the mills is fourteen inches. The cooling medium for the rolls is water at a temperature of 60-70 degrees. The bar, now of correct diameter, is carried by roller conveyors to the hot-beds. On the hot-beds the finished bars are allowed to cool gradually. At this point the bars have dropped to a temperature of 1500°, having lost about 600 to 700 degrees since the time they left the furnace as a part of the original rail. After the bars are cooled, they are cut to required length and made ready for shipment. All shapes are rolled with a $\frac{1}{64}$ allowance in size depending entirely on what they are to be used for. Should there be a rolling either under or oversize, the customer is notified of it, and if he refuses to accept it the lot is rejected. Tests are made every hour on all shapes and seven times a day on reinforcing bars. In these tests the steel is tested for hardness, tensile strength, elongation, and breaking point.

It is necessary at times to replace the rolls and machine them so that they can be used again. This is done in the machine shop at the mill.

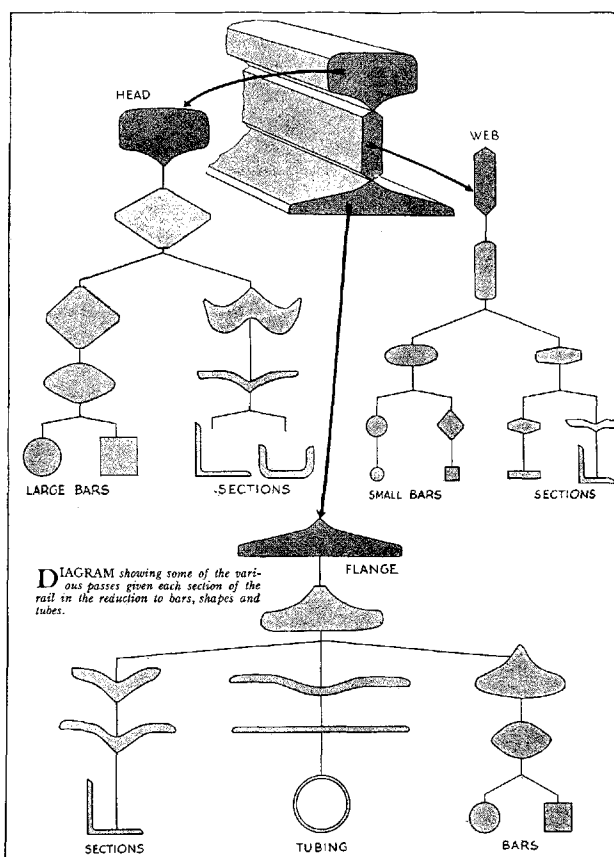
In the course of operations the bar may not be properly inserted or may twist while in the rolls, causing it to jam or "cobble" as they call it at the mill. This necessitates stopping operations until the bar is removed. All safety devices, such as false guides, covers, etc., are incorporated in the various machines to insure the utmost safety to the laborer. In case of accident the machinery can be stopped instantly.

Rail steel products are made in all mills in practically the same manner. Although mills may vary in minor details, the general principles are the same. The description is given as that of a bar, but other sections are rolled very much along the same lines.

Much of the rail steel, such as angles and other small sections, is used in the manufacture of farm implements. Steel posts for fences are also produced. Structural shapes are used in the manufacture of trusses, conveyor systems, and the like. Angles and tubing are used in the manufacture of beds. Road forms are made from rail steel by some manufacturers. Reinforcing bars are rolled from rails and find a wide field of uses in buildings, bridges, concrete chimneys, roads, and many other structures. The Hilliard Road bridge at Cleveland is entirely reinforced with 700 tons of rail steel. The New Dayton Sewage Disposal Plant and the Neil House at Columbus contain over 1,000 tons each. The demand for rail steel has been so great that there are 21 mills in the United States and one in Canada producing nearly 600,000 tons annually.

There has been much said of the breakage of rail steel reinforcing bars in fabricating and handling. Along with improvements in manufacture came a better understanding of how this high elastic limit steel should be fabricated, so that at the present time failures are gradually reducing in number.

A study of tests made with rail steel compared with structural and intermediate grade billet steel reinforcing bars shows that rail steel has a safety reserve when used on a par with ordinary steels. Considering this point further, a designing engineer has two alternatives when determining the grade of steel to specify, depending, of course, on



the nature of the regulating codes and specifications controlling his decisions; he may either use rail steel on a basis of a higher working stress than other grades, and thereby effect a noticeable saving in construction cost; or he may use rail steel on a basis of the same working stress as the other grades and insure to the public and himself a safety factor far in excess of that possible by the use of softer materials. To illustrate the point, rail steel, intermediate, and structural grade billet steel have working stresses of 20,000, 18,000 and 16,000 lbs. per sq. in. respectively; these also have a factor of safety of 2.50, 2.22 and 2.06, in the order mentioned. The saving in material thus effected of rail steel over the other two is 20 per cent over structural and 10 per cent over intermediate.

The factor of safety of rail steel is increased from 20 to 25 per cent. Tonnage savings are, of course, proportional to the differences between the allowable design stresses for the various grades of material. The physical properties of hard grade billet and rail steel are very similar, except that for equal tensile strength rail steel shows in most cases higher ductility, due to the density and homogeneity brought about by the additional mechanical "working" in the rail steel rolling process and the carefully controlled thermal treatment given the rail steel product.

The use of soft steel to the exclusion of harder grades is a heritage of the past based on the fact that years ago, when reinforced concrete was first used in construction, the only steel available for rolling into reinforcing bars was structural grade. This was the same steel used in the construction of steel frame structures, more widely

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used at that time, at the sacrifice of strength, to allow for punching, drilling, and fabrication.

Since then, considerable effort has been put forth in the development of materials having the same strength but less weight. This tendency toward economy is noticeable in the manufacture not only of reinforcing bars but of many other commercial products. In line with this the billet steel manufacturers are rolling intermediate grade steel, but, as the name implies, it is but a half-way measure in obtaining the valuable properties possessed by hard grade steels. There has been a tendency in permitting the use of intermediate grade and rail steel on the same stress basis. Although no economies can be effected in this way by the use of rail steel, rail steel still has a greater factor of safety than any other grade. Each year brings an increasing number of converts to the higher tensile steels.
